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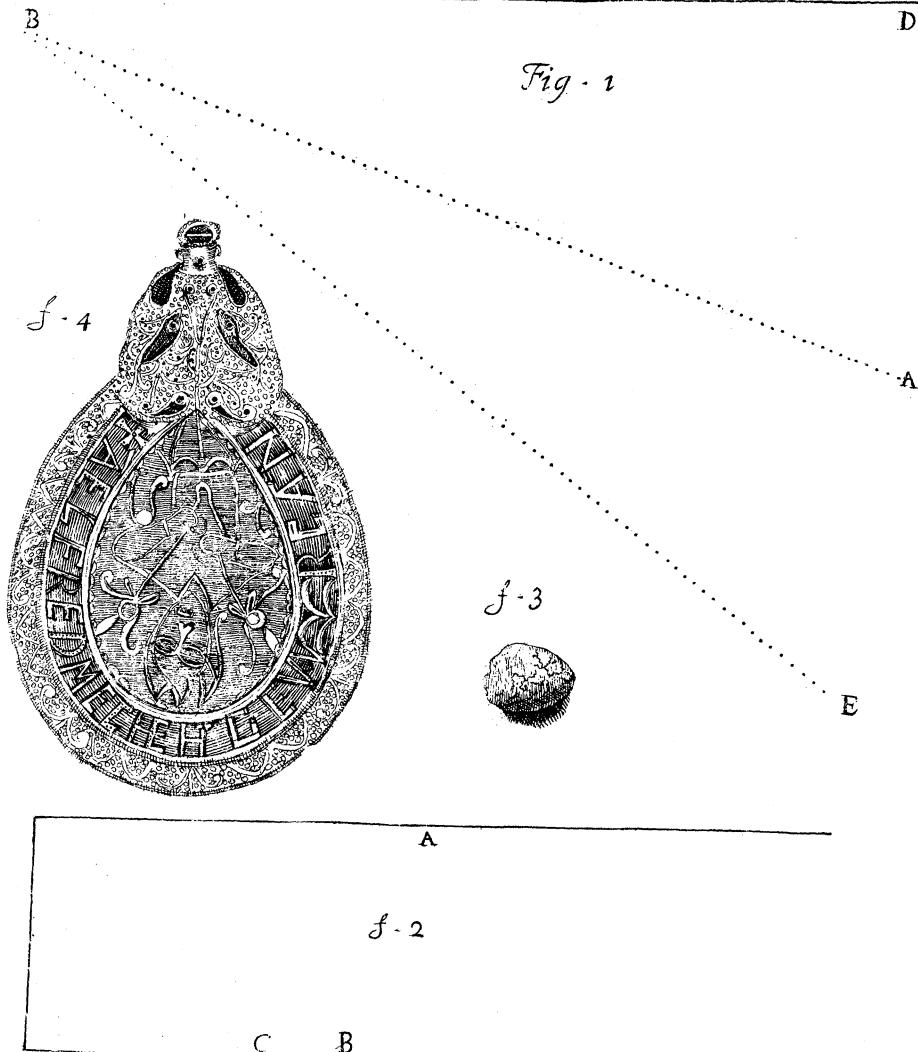
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II. *Some Experiments and Observations concerning Sounds.* By Mr. Walker, late of Brazen-Nose-College, Oxon. Communicated by Dr. W. Musgrave, Fell. Coll. Phys. and R. S.

Intending to try the Swiftnes of Sounds, I provided a Pendulum which had Two Vibrations in 1" of Time ; this I carefully adjusted at a Watch-maker's ; it was a Piece of small Virginal Wire with a Pistol Bullet at the end of it, the Length of it was $9 \frac{7}{16}$ Inches to the middle of the Bullet : I first made it about $\frac{1}{16}$ of an Inch longer, *viz.* $\frac{1}{4}$ of the length of a Pendulum that vibrates 2ds, but found it too slow, which I expected, because *Mersennus* tells us, [Harm. Univ. l. 2. pro. 26.] that Two Pendulums had their Vibrations one twice as quick as the other, whereas one was 2 Foot, the other $8 \frac{1}{2}$ Foot contrary to what *Galileo* demonstrates would happen if the Air did not hinder ; who proves that Pendulums of different lengths [would in *Vacuo*] have the times of their Vibrations in sub-duplicate Proportion to their lengths.

I took this Pendulum, and standing over against a high Wall I clapt Two small pieces of Boards together, and observed how long it was e're the Echo return'd, and I removed my Station till I found the Place whither the Echo return'd in about half a Second. But that I might distinguish the time more nicely, I clapt every Second of Time Ten or Fifteen times together ; so that by this Means I could the better discover whether the Distances betwixt the Claps and the Echoes, and the following Claps were equal. And though it be very difficult to be exact, yet I could come within some few Yards of the Place I sought for, thus : I observed the Two Places where I could but just discover that I was too near, and

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where

where I was too far off ; and from the Mid-way betwixt them I measured to the Wall, which Measure doubled, was the Space that the Sound moved in half a Second.

Here follow the Numbers of *English* Feet which a Sound moved in one Second of time at several Trials.

	<i>Feet.</i>	<i>Feet.</i>
Mersennus	1. 1474	9. 1292
	2. 2050	10. 1378
Florentine <i>Exper.</i>	3. 1148	11. 1292
Mr. Boyle's above	4. 1200	12. 1185
	5. 1256	13. 1278
	6. 1507	14. 1290
	7. 1526	15. 1200
	8. 1150	

I have here added Four other Numbers ; Two of them *Mersennus* mentions, but the first is that which he relies upon, being the Result of many Experiments that he tried ; he speaks of it in his *Ballist. prop. 39.* and elsewhere. The Second is grounded upon an Experiment which he did not try himself, and he questions whether the Observation were accurate : He says, the Sound of a great Canon, which was heard in the Night 11" after firing, passed every Second 1920 *French* Foot [Tom. 3. pa. 163.] The Third you have in the Book of the *Florentine Experiments*: The Academy *del Cimento* caused Six Harquebusses and Six Chambers to be fired one after another at the Distance of 5739 *English* Feet, and from the Flash to the Arrival of the Report of each was 5" : And repeating the Experiment at the mid-way, the Motion was exactly in half the time.

The Fourth Mr. *Boyle* mentions in his *Essay of Languid Motion*, *pa. 24.* where he says, he has more than once diligently observed, that the Motion of Sound passes above 400 Yards in 1".

The rest of the Numbers are collected from Experiments which I tried in several Places. When the Fifth was tried there was some Wind stirring, though not much. The Sixth, Seventh and Tenth were tried in a clear calm Morning : The Sixth and Seventh were tried in Two places in *St. John's Grove*.

The Twelfth Experiment was tried Two several Mornings, the Place where I stood was about 395 Yards from the Wall, and the Echo returned in 2". The Thirteenth was tried at the Distance of 213 Yards from the same Wall. And the Fourteenth another Morning at 215 Yards Distance from it ; in each of them the Sound was reflected in 1".

The Eighth Experiment was tried in *St. John's Cloister* ; and the Fifteenth in *New-College-Cloister*, where the Sound was tossed from one end to another, forward and back again several times, like that which *Mersennus* observed at *Milan*, where he thinks his *Voyce* was reflected thus at least Ten times, [*Reflex*, *ch. 20. p. 164.*] In *St. John's-Cloister*, which is 104 Foot and 7 Inches long, I stood at one end, and the Sound was repeated 11 times in 2". On the North side of *New-College-Cloister*, which is 160 Foot and 8 Inches long, I stood at one end and a Clap was repeated 8 times in a little more than 2" ; I guess there were 7 $\frac{1}{4}$ Echoes in 2". From the Number of Echoes here in 2", I computed the Swiftness of the Sound.

Mersennus and the *Academy del Cimento* conclude, That Sounds are all of the same *Quickness*, whether they be great or small, and whatever Temper the Air is of, though *Mersennus* was once of another Mind : But *Kircher*, from several Experiments, infers, That loud

Sounds move quicker than little ones, [Phon. pa. 14.] Dr. Plot also tells us, the Echo returned the Sound of a Pistol much quicker than a Voice; and that it repeated more Syllables in the Night than in the Day, [Oxf. pa. 7.] whence it follows that the Sound moved flower in the Night than in the Day. Kircher says, that an Echo which in the Night repeated Fourteen Syllables, repeated but Seven of them in the Day, [Musurg. li. 9. pa. 244.] which seems very odd. Because there seems to be so great Affinity betwixt the Undulation of Water, and the Propagation of Sound, therefore the Academy *del Cimento* tried some Experiments about the first; and they tell us, that the larger the Stone is which is thrown into the Water, and the greater the Force, by so much is the Undulation swifter: Though Gassendus had before affirmed, that the Undulations of Water are all equally swift. And I have often observed, that when a Stone has been thrown into the Water, the further the Undulations removed from the Center, the greater was the Distance from one another, even of those that rolled the same way: So that the Motion of each precedent Undulation was quicker than that which followed it. If this may be allowed for any Argument, it makes for Kircher's Opinion.

By some of those Experiments that I tried, I am inclined to think, that the Sound moved quicker when it was Calm, than in a Wind, even when the Sound moved half way with the Wind. Some other Experiments seem'd to me to confirm an Opinion of Kircher's, who says, That a Sound moves swifter at first than afterward, as is usual in other violent Motions.

There is seldom any Echo, where there is not some Wall, Wood, Bank, or such like, directly opposite, that may reflect the Sound to the Person that makes it; but in St. John's Grove, if you stand near the Gate leading from

from the College to the Grove, and clap, the Echo will return to you from the *Ball-Court*, though a Line drawn from you to the *Ball-Court* be not perpendicular to the Wall there, but as much oblique as the Line *AB* in *Fig. 1* is to the Line *BC*; where *A* represents the Gate, *BC* the *Ball-Court-Wall*, and *BD* another Wall. Or if you stand at *E* the Corner of the Grove next to *Trinity*, and clap, the Echo will return to you from the *Ball-Court*.

In the same Grove I stood about Twenty Yards from the same Gate, and the Gate being shut, I clapt, and at other times stamped, and the Echo returned from the Gate as loud, if not louder, than the Clap or Stamp.

An Echo reflected from a Gate or Door has usually a baser and duller Sound than that which is returned from a Wall, this being much brisker.

As I have been walking towards a Wall, I have clapped my Hands together several times, and I could distinguish the Echo from the Clap, till I came within Seven or Eight Yards of the Wall.

In the Cloisters, where, as was said before, the Echo was repeated several times, the first Repetition seemed to be flower than the second or the third; but of all the Repetitions, besides the first, the subsequent seemed flower than the precedent.

I have observed the Tossing of a Sound forward and back again, in very many Places where there are parallel Walls; and where the Distance of the Walls is less, there the Echoes follow one another quicker.

Wheresoever a Sound was thus tossed betwixt Two Walls, if I stood about the middle, I could hear the Sound twice as quick, that is, twice as often repeated in 1", as if I stood near one Wall; the Sound being reflected to me from both ends, when I stood in the middle.

In *Trinity Ball-Court*, which is represented by *Fig. 2.* when I stood and clapt at *B*, Three or Four Yards from the end of the Wall *C*, or at *A*, which is opposite to *B*, the Sound was tossed betwixt the opposite Walls; but not half so long time as when I stood betwixt the Walls. In Places where there are parallel Walls, not above Six or Eight Yards asunder, as in *Trinity Ball-Court*, and at the Entrance into *St. John's-Grove*, &c. I have heard the Echoes of a Clap following one another distinctly enough; but there the Echoes of a Musical Note, which was longer than a Clap, were so confused, that they seemed one continued long Sound: which makes me think, that the Echo in some Vaults, is nothing else but the Sound tossed betwixt the Side-Walls, and betwixt the Top and Bottom. This also makes me conjecture, that the Reason why Stringed Musical Instruments give a greater and longer Sound to the Strings, than if the Strings were fixt to a single Board, may be this; because the Sound is tossed from Side to Side in the Belly of the Instrument.